Cancer Incidence and Mortality Rates in Bermuda

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ABSTRACT

Objective: *To describe cancer and mortality rates in Bermuda and to compare such rates to those of the United States of America (USA).*
Methods: *Age-adjusted race-specific cancer incidence rates for Bermuda were calculated using the Bermuda Cancer Registry. These rates were then compared to USA cancer rates published by the National Cancer Institute.*
Results: *Overall age-adjusted incidence rate was 495 cases per 100 000 for Blacks and 527 cases per 100 000 for Whites. Incident cases were more frequent among men than women in both races. For Blacks, the highest incidences were prostate for men and breast for women, followed by colon/rectum and lung cancer. For Whites, if we exclude benign skin cancers, the picture was similar with the notable exception of lung cancer being more frequent than colon/rectum in White males.*
When Bermuda's rates were compared to those of the USA, overall cancer rates were similar in both countries. Rates in Bermuda were higher for cancer of the mouth, ovarian cancer (Black women), melanoma (Whites), colorectal cancer (White women) and breast cancer (White women). Lung and colorectal cancers were less frequent in Bermuda's Black population.
Conclusion: *Further epidemiological studies are needed to identify potential risk factors that could contribute to these differences. Screening and prevention strategies could be adjusted accordingly.*

Incidencia del Cáncer y Tasas de Mortalidad en Bermuda

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RESUMEN

Objetivo: *Describir las tasas de cáncer y mortalidad en la Bermudas y comparar estas tasas con las de los Estados Unidos de América (EE.UU.).*
Métodos: *Las tasas de incidencia de cáncer específicas por raza y ajustadas por edad en Bermuda, se calcularon usando el Registro de Cáncer de Bermuda. Estas tasas fueron comparadas con las tasas de cáncer en los EE.UU. publicadas por el Instituto Nacional del Cáncer.*
Resultados: *La tasa general de incidencia ajustada por edad fue de 495 casos por 100 000 negros y 527 casos por 100 000 blancos. Los casos incidentes fueron más frecuentes entre los hombres que entre las mujeres en ambas razas. En el caso de los negros, las incidencias más altas estuvieron en la próstata para los hombres y en las mamas para las mujeres, seguidas por el cáncer de colon y recto, y el cáncer de pulmón. En el caso de los blancos, si se excluyen los cánceres benignos de la piel, el cuadro fue similar con la excepción notable de que el cáncer pulmonar fue más frecuente que el cáncer de colon y recto en los varones blancos.*
Cuando las tasas de Bermudas se compararon con las de EE.UU., las tasas generales de cáncer resultaron ser similares en ambos países. Las tasas en Bermuda fueron más altas para el cáncer de la boca, el cáncer ovárico (mujeres negras), el melanoma (blancos), el cáncer del colorectal (mujeres blancas), y el cáncer de mamas (mujeres blancas). Los cánceres de pulmón y colorectal fueron menos frecuentes en la población negra de Bermudas.

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Conclusión: *Se necesita continuar los estudios epidemiológicos a fin de identificar los factores de riesgo potenciales que podrían contribuir a estas diferencias. Las estrategias de pesquisaje y prevención podrían ajustarse en consecuencia con ello.*

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INTRODUCTION

Bermuda is an archipelago of less than 60 square kilometres in the Atlantic Ocean situated about 1000 km east of the coast of the United States of America (USA). In 2000, Bermuda had a population of 62 059, 60% of whom are of African descent (1). A preliminary analysis performed by local physicians indicated that the rate of cancer incidence in Bermuda was rising and could be higher than expected (unpublished results). Furthermore, although no reports of standardized cancer rates in Bermuda were ever published, there existed a general concern among the local population that the cancer rate in Bermuda was higher than in other countries. A preliminary report from the University of Texas South-western Medical Centre at Dallas concluded that the incidence rate of breast cancer and colon cancer in White females was higher in Bermuda than in the USA. In the same report, no statistically significant differences in rates were found between Bermuda and the USA for prostate cancer, colon cancer in males and ovarian cancers, although some differences were observed (2).

To address the necessity of evaluating environmental carcinogens, as well as to have a better picture of the incidence rates of cancer in Bermuda, it was decided to use the Bermuda Tumour Registry to evaluate the crude and age-adjusted incidence rates of cancer in Bermuda. At the request of the local health authorities, we also compared these rates to those of the population of the USA. We report here the crude and age-adjusted incidence rates of cancer in Bermuda for the years 2000–2003 as well as age-adjusted rate ratios when Bermuda's rates were compared to those of the USA. Time trends for 1991–2003 are also shown.

METHOD

Cancer cases and mortality

Data on new cancer cases for 1991–2003 were extracted from the Bermuda Tumour Registry. Cases were categorized by their primary site using the International Classification of Diseases for Oncology (ICD-O) of the World Health Organization. Subcategories were also created for leukaemia, lymphomas and skin cancer using the histology type of the ICD-O. Unless specified otherwise, *in-situ* carcinomas and basal and squamous skin cancers were excluded from the analyses. Mortality data were obtained through the Bermuda Department of Health. Data on cancer incidence in the USA were from the National Cancer Institute (3, 4). All nominal data were extracted from the databases before analysis and their use was approved by the chief medical officer of Bermuda.

Calculation of crude and age-adjusted rates

Population data were obtained directly through the Bermuda Statistics Department. The population data for 1991 refers to the actual data from the 1991 census, while population data for 1992–2003 are projections computed by the Statistic Department from the 1991 census data. It is noteworthy that the information on the race of each cancer patient is determined by the staff of the oncology service. It is not self-reported, such as in the census data. Because race is determined differently for cancer cases than for the general Bermuda population, a bias may be present in race-specific rates. It is however expected to be small. Age-adjusted rates were weighted on the 2000 USA standard population by 5-year age groups. Data on the 2000 standard population were gathered from the United States National Cancer Institute (5). When combined rates are presented (such as males and females combined), the adjustment on age was performed on the combined rates (total cases/total population) and not on sex-specific rates (such as taking the mean of adjusted sex-specific rates).

Statistical analysis

An adaptation of the method described by Bouyer *et al* (6) was used to compute *p*-value and confidence intervals for rate ratios. For comparison between Bermuda and the USA, the *p*-value was obtained from the *Z* statistic using the equation:

$$Z = \frac{\ln SR_{Bermuda} - \ln SR_{US}}{\sqrt{\text{Variance}(\ln SRR_{Bermuda})}}$$

where $SR_{Bermuda}$ is the age-adjusted rate in Bermuda, SR_{us} is the age-adjusted rate in the USA and $SRR_{Bermuda}$ is the standardized rate ratio in Bermuda compared to the USA. The variance of $\ln SRR_{Bermuda}$ was obtained using the equations:

$$\text{Variance}(\ln SRR) = \frac{\text{Variance}(SR_{Bermuda})}{SR^2_{Bermuda}} + \frac{1}{d_{US}}$$

$$\text{Variance}(SR_{Bermuda}) = \sum_{k=1}^{18} w_k^2 \frac{d_{kBermuda}}{n^2_{kBermuda}}$$

where d_{US} is the number of cases in the USA for the period studied, k indexes 5-year age groups, w_k is the 2000 US population weight in the age group k, $d_{kBermuda}$ is the number of cases in the age group k in Bermuda, and $n_{kBermuda}$ is the population in the age group k in Bermuda. The *p*-values for comparisons between races were computed similarly, except

for the variance of the standardized rate ratio, for which we used the following equation:

$$\text{Variance}(\ln SRR) = \frac{\text{Variance}(SR_{Blacks})}{SR^2_{Blacks}} + \frac{\text{Variance}(SR_{Whites})}{SR^2_{Whites}}$$

Confidence intervals (CI) were calculated as followed:

$$\text{CI95\%}(SRR) = SRR \times e^{\pm Z_{\alpha/2}\sqrt{\text{variance}(SRR)}}$$

where $Z_{\alpha/2} = 1.96$.

To assess the presence of a temporal variation between 1991 and 2003, Poisson regression was performed on age-adjusted rates using the year of diagnosis as the main independent variable. The annual per cent change (APC) was computed from the coefficient estimate β of the regression using the equation:

$$APC = (1 - e^{\beta}) \times 100$$

Overall, a p-value < 0.05 was considered statistically significant.

RESULTS

Number of cases

At the time these analyses were done, the Bermuda Cancer Registry included new cancer cases from 1991 to 2003. There were a total of 3503 cases registered in the database, including basal and squamous skin cancers, *in-situ* carcinoma and reports of transformed cells in urine without the evidence of a urinary tumour.

Crude and age-adjusted incidence rate

In general, compared to the US standard population, Bermudians aged > 65 years old were under-represented while young adults 25–40 years were over-represented (data not shown). Age-standardized rates of cancers affecting older individuals were thus higher than crude rates. The opposite was also true for cancers striking most frequently at mid-age. Tables 1 and 2 show the crude and age-adjusted incidence rates for cancer in 2000–2003 by primary site and gender for Blacks and Whites, respectively. Not all primary sites are reported, only those with more than 5 cases per 100 000, or those with clinical significance are shown. The age-adjusted

Table 1: Crude and age-adjusted incidence rates of cancer in Bermuda (2000–2003) by primary site and sex (Blacks)

Cancer site or type	Crude incidence rate (per 100 000)			Age-adjusted incidence rate[a] (per 100 000)		
	Total	Females	Males	Total	Females	Males
All sites[b]	439.9	373.7	514.7	495.3	394.1	645.2
Oral cavity	14.1	5.1	24.2	14.5	4.9	27.5
Digestive system	85.0	78.3	92.7	103.1	89.8	119.9
Stomach	11.4	8.8	14.3	14.5	9.8	21.9
Colon and rectum	46.2	44.2	48.5	55.5	52.1	58.1
Pancreas	14.7	17.7	11.4	18.0	19.9	13.6
Respiratory system and intra-thoracic organs	43.5	30.3	58.4	47.0	31.4	68.3
Lung and bronchus	38.2	29.1	48.5	41.8	30.3	57.6
Skin (including basal and squamous)	5.4	3.8	7.1	5.8	3.6	9.6
Basal and squamous	4.7	2.5	7.1	5.1	2.4	9.6
Melanoma	0.7	1.3	0.0	0.6	1.1	0.0
Breast	76.3	142.6	1.4	83.5	145.0	1.4
Female genital system	–	48.0	–	–	50.7	–
Endometrium and *corpus uteri*	–	10.1	–	–	10.8	–
Cervix uteri		7.6			7.6	
Ovary	–	24.0	–	–	26.4	–
Male genital system	–	–	256.6	–	–	326.5
Prostate	–	–	255.2	–	–	325.1
Urinary system[c]	20.8	15.1	27.1	24.1	15.8	38.8
Urinary bladder[c]	10.7	6.3	15.7	13.7	7.4	24.0
Brain and other nervous system	6.7	6.3	7.1	7.2	6.2	9.4
Endocrine system	1.3	1.3	1.4	1.5	1.2	1.8
Lymphomas	16.7	13.9	20.0	17.6	17.7	20.9
Hodgkin's disease	4.0	3.8	4.3	3.9	3.6	4.2
Non-Hodgkin's lymphomas	12.7	10.1	15.7	13.7	11.1	16.7
Multiple myeloma	10.0	8.8	11.4	10.5	8.9	11.5
Leukaemia	8.7	10.1	7.1	10.0	10.5	9.3
Lymphocytic	2.7	2.5	2.9	2.6	2.2	3.1
Myeloid	5.4	6.3	4.3	6.8	7.1	6.2
Other and unspecified primary sites	8.0	11.4	4.3	10.6	13.2	7.3

[a] Age-adjusted to the 2000 United States standard population by 5-year age groups.
[b] Excluding basal and squamous skin cancers and in-situ carcinomas.
[c] Including reports of transformed cells in urine without evidence of a urinary tumour (C67.9 – urinary bladder, NOS).

Table 2: Crude and age-adjusted incidence rates of cancer in Bermuda (2000–2003) by primary site and sex (Whites)

Cancer site or type	Crude incidence rate (per 100 000)			Age-adjusted incidence rate[a] (per 100 000)		
	Total	Females	Males	Total	Females	Males
All sites[b]	462.9	482.1	443.7	527.4	507.5	568.4
Oral cavity	19.2	10.0	28.3	22.2	10.8	38.2
Digestive system	94.1	109.1	79.0	111.8	118.3	99.1
Stomach	9.1	8.1	10.1	11.3	8.9	13.4
Colon and rectum	61.7	74.7	48.6	74.0	82.0	62.9
Pancreas	9.1	16.2	2.0	12.3	18.5	2.1
Respiratory system and intra-thoracic organs	50.6	40.4	60.8	62.4	44.0	91.1
Lung and bronchus	44.5	38.4	50.6	54.9	41.7	76.5
Skin (including basal and squamous)	140.4	104.7	176.3	163.1	112.7	228.3
Basal and squamous	94.1	64.6	123.7	114.9	71.6	170.8
Melanoma	45.3	40.1	50.6	46.9	41.1	54.7
Breast	80.9	161.3	0.0	87.1	169.2	0.0
Female genital system	–	50.6	–	–	53.6	–
Endometrium and *corpus uteri*	–	24.2	–	–	26.3	–
Cervix uteri		6.1			5.8	
Ovary	–	14.2	–	–	14.9	–
Male genital system	–	–	138.1	–	–	175.3
Prostate	–	–	127.9	–	–	167.7
Urinary system[c]	25.2	18.2	32.3	30.1	20.0	41.3
Urinary bladder	18.2	14.2	22.2	21.9	15.9	27.8
Brain and other nervous system	4.0	6.0	2.1	3.7	4.9	2.6
Endocrine system	2.0	2.0	2.1	1.8	1.1	2.4
Lymphomas	25.2	30.2	20.2	26.3	29.3	20.9
Hodgkin's disease	7.1	10.1	4.1	5.3	7.4	3.0
Non-Hodgkin's lymphomas	16.1	18.1	14.1	18.0	19.5	14.5
Multiple myeloma	2.0	4.0	0.0	2.5	4.1	0.0
Leukaemia	8.1	4.1	12.2	9.6	4.2	19.1
Lymphocytic	2.0	0.0	4.1	2.8	0.0	7.8
Myeloid	6.1	4.1	8.1	6.8	4.2	11.2
Other and unspecified primary sites	9.1	8.1	10.2	11.9	9.2	14.5

[a] Age-adjusted to the 2000 United States standard population by 5-year age groups.
[b] Excluding basal and squamous skin cancers and in-situ carcinomas.
[c] Including reports of transformed cells in urine without evidence of a urinary tumour (C67.9 – urinary bladder, NOS).

incidence rate for all sites (excluding basal and squamous skin cancer and *in-situ* carcinomas) was 495.3 cases per 100 000 for Blacks and 527.4 cases per 100 000 for Whites. New cases were more frequent among men than women (645.2 *vs* 394.1 cases per 100 000 for Blacks and 568.4 *vs* 507.5 cases per 100 000 for Whites). For Blacks, the highest incidences were prostate for men and breast for women, followed by colon/rectum and lung cancer. For Whites, if benign skin cancers, are excluded the picture was similar with the notable exception of lung cancer being more frequent than colon/rectum in White males.

Rates ratios for Blacks compared to Whites

Table 3 shows the age-adjusted rate ratios (RRs) for Blacks compared to Whites. For all sites combined, Black females had a significantly lower rate when compared to White females (RR = 0.65 [CI 95% 0.56, 0.75], $p < 0.001$), but Black males had a slightly non-significant higher incidence than White males (RR = 1.12 [CI 95% 0.95, 1.30], $p = 0.17$). This was also observed in the US population (3, 7). In males,

Table 3: Age-adjusted rate ratios for Blacks compared to Whites for selected cancer sites according to sex.

Cancer site or type	Age-adjusted rate ratio[a] [and 95% confidence interval] (Blacks vs. Whites)	
	Males	Females
All sites[b]	1.12 [0.95 – 1.30]	0.65 [0.56 – 0,75]**
Oral cavity and mouth	0.92 [0.47 – 1.78]	0.40 [0.15 – 1,07]
Colon and rectum	0.86 [0.50 – 1.46]	0.43 [0.27 – 0.69]**
Pancreas	1.89 [0.35 – 10.40]	1.65 [0.63 – 4.32]
Lung and bronchus	1.23 [0.75 – 2.03]	0.40 [0.24 – 0.68]**
Breast	–	0.73 [0.56 – 0.94]*
Endometrium and corpus uteri	–	0.67 [0.30 – 1.52]
Ovary	–	0.81 [0.41 – 1.57]
Prostate	1.49 [1.15 – 1.94]**	–
Non-Hodgkin's lymphomas	1.09 [0.40 – 2.93]	0.64 [0.25 – 1.64]
Leukaemia	0.64 [0.23 – 1.80]	0.79 [0.24 – 2.61]

* $p < 0.05$, ** $p < 0.01$
[a] Age-adjusted to the 2000 United States standard population by 5-year age groups.
[b] Excluding basal and squamous skin cancers and in-situ carcinomas.

only prostate cancer reached statistical significance (RR = 1.49, p = 0.003). Except for pancreatic cancers, Black females had lower incidence rates for almost all cancer sites. Statistical significance was reached for colon/rectum (RR = 0.43, p = 0.0005), lung (RR = 0.40, p = 0.0008), and breast cancers (RR = 0.73, p = 0.013).

Time trends of common cancers

Table 4 shows the annual per cent change for the most frequent cancer site between 1991–2003. For all sites combined, Poisson regression yielded a statistically significant annual increase of 2.7% for females and 2.6% for males. This is in contrast with US figures where rates decreased in American males (1.6% annual decreased) and stayed constant in females between 1992–2001 (7). The trends for specific cancer sites must be viewed with caution since the number of cases in Bermuda was small for this type of analysis. Statistically significant increasing trends were identified for prostate cancer in males (7.7% annual increase, p < 0.01) and lung cancer (12.2% annual increase for females and 4.0% annual increase for males). The trends for colorectal cancer in females were borderline significant (6.1% annual increase, p = 0.06).

Table 4: Annual per cent change for the most frequent cancer sites

Cancer site	Annual per cent change	*p*-value
All sites (females)	2.7	< 0.01
All sites (males)	2.6	< 0.01
Breast (females)	1.8	0.10
Prostate	7.7	< 0.01
Lung (females)	12.2	< 0.01
Lung (males)	4.0	0.02
Colon and rectum (females)	6.1	0.06
Colon and rectum (males)	0.1	0.95

Comparisons with US data

Rate ratios (RRs) of Bermuda compared to USA were computed for the years 1997 to 2001. Only cancer sites with more than 25 cases in 1997–2001 were analysed. Table 5 shows the age-adjusted rate ratios (RRs) for selected cancer sites. When comparisons between the Bermudian and American figures were performed, it was noted that important differences existed according to race. Results will therefore be discussed separately for Blacks and Whites.

Blacks

For members of the Black population, the overall cancer incidence rate was similar in Bermuda and the USA (RRs = 0.94 in females and 1.01 in males). The cancer sites in Black Bermudan residents that showed a significantly

Table 5: Age-adjusted rate ratios for Bermuda compared to USA for selected cancer sites according to race and sex

Cancer site or type	Age-adjusted rate ratio[a] [and 95% confidence interval] (Bermuda vs. USA)			
	Blacks		Whites	
	Males	Females	Males	Females
All sites[b]	1.01 [0.92 – 1.11]	0.94 [0.84 – 1.04]	1.12 [0.99 – 1.27]	1.35 [1.21 – 1.50] **
Oral cavity and mouth	1.82 [1.25 – 2.67] **	1.16 [0.55 – 2.44]	2.48 [1.44 – 4.26] **	2.77 [1.49 – 5.16] **
Colon and rectum	0.68 [0.48 – 0.96] *	0.62 [0.43 – 0.90] *	0.92 [0.61 – 1.38]	1.77 [1.32 – 2.38] **
Pancreas	0.67 [0.30 – 1.49]	1.29 [0.77 – 2.18]	0.49 [0.11 – 2.20]	1.16 [0.52 – 2.59]
Lung and bronchus	0.67 [0.50 – 0.89] **	0.44 [0.29 – 0.66] **	0.81 [0.54 – 1.21]	1.16 [0.83 – 1.62]
Melanoma	–	–	2.06 [1.41 – 3.00] **	2.85 [1.97 – 4.12] **
Breast	–	1.14 [0.96 – 1.35]	–	1.33 [1.10 – 1.61] **
Endometrium and corpus uteri	–	0.80 [0.44 – 1.44]	–	0.81 [0.46 – 1.43]
Ovary	–	2.24 [1.43 – 3.52] **	–	1.90 [1.16 – 3.10] *
Prostate	1.13 [0.98 – 1.31]	–	1.23 [0.99 – 1.53]	–
Non-Hodgkin's lymphomas	0.85 [0.45 – 1.59]	0.89 [0.46 – 1.75]	0.59 [0.27 – 1.26]	0.98 [0.51 – 1.89]
Leukaemia	1.07 [0.51 – 2.24]	0.87 [0.39 – 1.96]	1.26 [0.61 – 2.60]	0.88 [0.36 – 2.11]

* p < 0.05, ** p < 0.01.

[a] Age-adjusted to the 2000 United States standard population by 5-year age groups.

[b] Excluding basal and squamous skin cancers and in-situ carcinomas.

higher incidence in comparison with the rates for American Black residents in the USA included ovary (RR = 2.24 [CI 95% 1.43, 3.52]) and oral cavity for males (RR = 1.82 [CI 95% 1.25, 2.67]). Lung and bronchial cancers in Bermuda Blacks had a significantly lower rate when compared to that of the USA (RRs = 0.67 [CI 95% 0.50, 0.89] for males and 0.44 [CI 95% 0.29, 0.66] for females. Colorectal cancer also had a lower incidence in both genders (RRs = 0.68 [CI 95% 0.48, 0.96] for males and 0.62 [CI 95% 0.43, 0.90] for females).

Whites

The incidence rate of cancer in Whites for all sites was significantly higher in Bermuda when compared to the USA for both genders combined (RR = 1.22 [CI 95% 1.13, 1.32]). However, rate ratios for all sites reached statistical significance for females (RRs = 1.35, $p < 0.001$) but not for males (RR = 1.12, $p = 0.07$). Cancer sites for Bermuda Whites that had a significantly higher rate compared to that of the USA were oral cavity (RRs = 2.48 [CI 95% 1.44, 4.26] for males and 2.77 [CI 95% 1.49–5, 16] for females, melanoma (RRs = 2.06 [CI 95% 1.41, 3.00] for males and 2.85 [CI 95% 1.97, 4.12] for females, colon and rectum in females (RR = 1.77 [CI 95% 1.32, 2.38]), and breast in females (RR = 1.33 [CI 95% 1.10, 1.61]). Among Bermuda Whites there was no statistically significant lower rate when compared to US rates. However, pancreatic cancer in males (RR = 0.49 [CI 95% 0.11, 2.20], *p*-value = 0.35) and non-Hodgkin's lymphoma in males (RR = 0.58 [CI 95% 0.27, 1.26], *p*-value = 0.17) had rate ratio quite below 1.0 without reaching statistical significance.

Mortality rate

Table 6 shows the crude and age-adjusted mortality rate according to cancer site and gender for 1997–2000. Unfortunately, race-specific mortality rates were not available at the time these analyses were done. Only cancer sites for which more than 15 deaths occurred in 1997–2000 are shown. The age-adjusted mortality rate for neoplasms in 1997–2000 was 291.8 deaths per 100 000. As in other industrial countries, lung cancer had the highest mortality rate but sex-specific mortality rates of breast and prostate cancers were higher than lung cancer mortality rates. Because race-specific mortality rates were not available for Bermuda, and because the racial demographics were different in Bermuda and the USA, a comparison of mortality rates between the two countries would be severely biased and is therefore not presented here.

DISCUSSION

In this study, the incidence rate of cancer in Bermuda is presented. A literature review did not allow us to identify other published reports of cancer incidence rates in Bermuda, nor was Bermuda included in international databases such as Globocan (8). Furthermore, with the exception of a preliminary report from the University of Texas South-western Medical Centre at Dallas (2), this study is the first to show age-standardized rate ratios comparing Bermuda cancer rates to another country.

In general, cancer rates were not significantly higher in Bermuda when compared to the USA, except for White females. However, rates for some cancer sites were shown to be different in the two countries. The highest RRs were observed for melanoma in Whites and for oral cavity cancers (mostly due to tongue, salivary gland, floor of mouth and tonsillar cancers). Race-specific rate ratios went in opposite directions for some cancer sites, namely hormonal cancer in females and colorectal cancers. Finally, lung cancer was less frequent in Bermuda, but only for Blacks. It was well beyond the scope of this paper to identify specific risk factors that could explain the differences observed between the two countries. Despite the fact that only well-designed epidemiological studies would help to clarify the factors actually involved, we discuss here some probable explanations using well-known risk factors for selected cancer sites.

Table 6: Crude and age-adjusted mortality rates of cancer in Bermuda (1997-2000) by primary site and sex (all races)

Cancer site or type	Crude mortality rate (per 100 000)			Age-adjusted mortality rate[a] * (per 100 000)		
	Total	Female	Male	Total	Female	Male
All sites	229.8	207.1	254.3	291.8	234.8	378.9
Colon and rectum	15.1	16.5	13.6	20.6	20.3	21.2
Pancreas	13.5	16.5	10.2	19.3	21.0	15.9
Lung and bronchus	40.4	25.2	56.7	48.5	26.6	81.1
Breast	–	45.7	–	–	49.2	–
Ovary	–	14.9	–	–	17.4	–
Prostate	–	–	49.2	–	–	83.5
Non-Hodgkin's lymphomas	6.1	6.3	5.9	7.1	7.6	6.5

[a] Age-adjusted to the 2000 United States standard population by 5-year age groups.

The most recognized risk factors for oral cavity cancers are tobacco use (smoking and chewing), alcohol consumption and a diet poor in fruits and vegetables (9–11). A higher rate of exposure to smoke (first-hand or second-hand) in Bermuda seems unlikely because rate of lung cancer was found to be lower in Bermuda. Differences in diet and/or alcohol consumption (quantity or type of liquor) might be involved.

As expected, rate of melanoma was higher in Bermuda. The analysis was conducted only for Whites because very few cancer cases were found in Blacks. Exposure to ultraviolet rays is likely higher in Bermuda compared to the USA and could explain most of the difference observed (12).

Hormonal cancer rate in females was higher in Bermuda, but the pattern differed between Blacks and Whites. Ovarian cancer rate was higher in both groups, but reached statistical significance only in Blacks. Breast cancer was significantly higher in Whites, but not in Blacks. Low parity and late first pregnancy, two factors that are usually associated with higher socio-economic status, are risk factors for hormonal cancer in women (13, 14). Because the socio-economic status in Bermuda is generally higher compared to the USA, it could explain part of the difference observed. In the case of breast cancer, a better rate of diagnosis following an aggressive screening programme in Bermuda could also be involved.

White females had a significantly higher rate of colorectal cancer, while the rate was similar in White males and lower in Blacks. We found this result puzzling. Besides distinctive diet, a higher rate of smoking compared to Blacks, reflected by the higher rate of lung cancer, could be involved (15,16). Differences in alcohol consumption could also play a role, which would be consistent with the higher rate of oral cancer.

The rate of lung cancer was similar in Whites, but significantly lower in Blacks. The most important risk factors for lung cancer is cigarette smoking (17–19). Rates of smoking could be lower in Bermudian Blacks compared to American Blacks. A lower exposure to industrial carcinogenic might also be involved.

Valid comparison of age-adjusted rates between two countries requires cancer registries of similar completeness. In this study, we did not specifically assess the procedure used to gather cancer cases in Bermuda. Such an analysis was previously performed in 2001 by a team from the University of Texas South-western Medical Centre at Dallas (2). In their unpublished report, the authors concluded that "*overall, the tumour registry in Bermuda can be rated as excellent as compared to registries in the US*". Such a conclusion was based on several observations. Of note, standardized methods are used by the staff at the oncology service for the management of their registry. The cases are mainly screened using pathology results, but the small size of the island and the fact that it has only one health centre increase communication and help identifying cases. Some cases are known to be diagnosed off island but most return to Bermuda at some point for treatment and are included then. Access to healthcare through more widespread insurance coverage might however be higher in Bermuda. This could increase the diagnosis rate for cancer in Bermuda, or at least shift the diagnoses toward earlier stages. On the other hand, death certificates do not seem to be routinely sent to the oncology department. Such a method is often used in the USA to complete registries with cases that could have been missed. It is possible, although impossible to precisely determine, that the rate in the USA could be slightly higher because of such systematic screening of death certificates. Nevertheless, overall, the Bermudian and American registries are expected to be of comparable completeness.

It is unfortunate that race-specific mortality rates were not available. Without controlling for race, the difference in mortality rates according to race would severely bias any comparison made between the two countries. That being said, preliminary analyses showed that mortality rate was significantly higher in Bermuda compared to that in the USA (results not shown). Some site-specific mortality rate ratios seemed higher than what could be expected, even when one considers the race bias. Therefore, it is suggested that further studies be conducted on the mortality rate for prostate, pancreas, ovary and breast cancer. In particular, it should be addressed whether the increased mortality rate is compatible with the increased diagnosis rate, and whether these cancer sites are diagnosed at later stages in Bermuda, as compared to the United States of America.

These results will be helpful for local physicians to direct their prevention and screening strategies. Epidemiological studies could also be initiated to identify potential risk factors that could explain the differences observed.

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